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of statistics of this nature will, it is believed, become more and more manifested as they accumulate. In later publications it is hoped to present more detailed analyses.

Cooperation Invited.

The tables herein presented represent merely a beginning in the publication of industrial morbidity statistics. It is intended to extend the collection of sickness statistics to as many plants as will cooperate by furnishing reports periodically. While the number of reporting associations has been considerably augmented of late, it is hoped that more establishments will report the disabilities occurring among their employees.

ACKNOWLEDGMENTS.

Acknowledgments are made to those corporation managers and association secretaries whose generous assistance has made possible the inauguration of the present plan to obtain current information of the incidence of disease among the wage-earning population.

RECENT EXPERIMENTS IN THE CONTROL OF AIR DUSTINESS.¹

By O. M. SPENCER, Passed Assistant Surgeon (R.), United States Public Health Service.

We may assume as generally accepted that tuberculosis never appears unless the tubercle bacilli are present, and that even when such bacilli are present, tuberculosis does not develop unless they are in sufficient numbers to overthrow normal resistance or unless they find in the ultimate victim a physical condition sufficiently subnormal to predispose him to their virulent assaults. Factors that may so predispose an individual vary. Perhaps they may be due to the virulence of the tubercle bacilli, to racial stock, or to emaciation resulting from various causes, such as deterioration caused by alcohol, or from fatigue, or like factors within the individual; or they may come from more remote factors that influence or tend to develop physical disabilities, such as poor ventilation, exposure to extremes of heat and cold, wet processes, inadequate lighting, bad housing, low standards of living, insanitary community conditions, or unhealthy climatic conditions.

Because there are these ramifications of the influencing factors of tuberculosis, a restriction in the scope of this subject may not be out of harmony with the general program. I am, therefore, taking the liberty to discuss the results of some recent studies made by

¹ Read at the North Atlantic Tuberculosis Conference held at Richmond, Va., Oct. 7-8, 1920.

United States Public Health Service officers, of air conditions prevailing in certain occupations and having a tendency to excite or accelerate the development of tuberculosis.

It is commonly known that there are certain principal occupations creating air conditions that tend to produce characteristic fibroid changes in the lungs, commonly designated as pneumoconiosis, which changes predispose the worker to infection from the tubercle bacilli. I refer here to such trades as those followed by cutlery makers, filers, grinders, abrasive workers, polishers, buffers, manufacturers of jewelry, brass workers, finishers, sand blasters, saw filers, toolmakers, glass blowers, glassworkers, cotton workers (because of mineral substances used in sizing), marble and stone quarry men, molders, potters, miners of copper, gold, silver, graphite, iron, lead, zinc, mica, phosphate, spar, and quicksilver. These trades are typical, and the list inserted here is not at all complete. The important point is not how many trades carry this exposure, but what preventive measures are available when a trade tends to produce an air dustiness of particles capable of producing fibroid changes in the lung tissue, or capable of filling the lung with foreign matter, thereby restricting its capacity to function.

We have become accustomed to-day to certain standard methods for air purification in industrial plants. These methods take the form of hoods, exhausts, and fume lines usually beginning at or near the work plane and following certain engineering specifications, exhausting at a place sufficiently remote and protected to control the hazards arising from the occupation. In certain occupations where it has been thought that such fume lines could not be satisfactorily installed and operated, wet processes have been introduced. In point of origin, the wet process antedates the exhaust as a means for controlling dusty operations. To a large extent these two processes have given a sense of security to the operator and the operative.

States as governmental units, and, in some instances, municipal authorities, have endeavored to standardize such safety devices by fixing the size of the fume line, the number of branches that may enter a main without increasing the size of the main, the angle at which such branch pipes must enter the main pipes, the strength of the exhaust as determined by anemometer or U-tube readings, and like precautions. These regulations, occasionally enforced by factory inspection, have given an added sense of security to the hazardous occupations. The great question is, however, Is this sense of security fancied or real? Certain observations made by officers of the Public Health Service aroused a doubt as to the adequacy of these so-called protective devices and led to a comprehensive research. The results of the investigation show that in many instances,

because of mistakes in planning and installation and because of an imperfect method for determining the efficiency of such devices, operatives have been exposed to almost as great a hazard as if no protective devices had been installed. The crux of the problem as now presented in the industries cited is largely the production of a method for checking up the efficiency of the apparatus installed; and I shall endeavor to show that such a check can best be made, not by anemometer or U-tube readings, but by air samples taken at the plane of work and dust counts made therefrom.

All dust counts mentioned in this work were made from samples collected by the Palmer water-spray machine, and refer to the number of one-fourth standard unit dust particles per cubic foot of air, as classified by Palmer,² and arranged according to size, from 1 to 10 microns. It was shown by Dr. McCrea, in the report of the Miners' Phthisis Prevention Committee, of Johannesburg, South Africa,³ that the dust extracted from the lungs of deceased miners by acid oxidation consisted of particles from 12 microns to less than 1 or 2 microns in diameter. The majority of particles were found in the smaller sizes.

It has been the almost universal belief that, of the two main types of control of air dustiness, wet grinding is safer and has a smaller dust hazard than dry grinding under an exhaust system. This in some instances has been proved false by recent studies conducted by Winslow and Greenburg in an ax-grinding factory.⁴ In this plant the owners were worried by the dry grinding with an exhaust system and were satisfied with a wet-grinding process, and so sought advice as to a feasible plan for correcting the former.

Dust counts of samples were collected by the Palmer water-spray machine in the wet and dry grinding shops by Winslow and Greenburg, with the following results:

Wet-grinding shops.

Number of samples.	Number of dust particles per cubic foot of air. (One-fourth standard unit.)		
	Minimum.	Maximum.	Average.
32	a 870,000	50,000,000	15,800,000

a This was the only sample below one million.

² Palmer, G. T., Coleman, L. V., and Ward, H. C., A Study of Methods for Determining Air Dustiness: American Journal of Public Health, Vol. VI, p. 1049, 1916.

³ Miners' Phthisis Prevention Committee—General Report. Johannesburg, 1916.

⁴ Winslow, C.-E. A., and Greenburg, Leonard, A Study of the Dust Hazard in the Wet and Dry Grinding Shops of an Ax Factory: Public Health Reports, vol. 35, No. 41, Oct. 8, 1920, pp. 2393-2401. Reprint No. 616.

Dry-grinding shops with exhaust system.

Number of samples.	Number of dust particles per cubic foot of air. (One-fourth standard unit.)		
	Minimum.	Maximum.	Average.
10	51,500	400,000	154,500

By these experiments Winslow and Greenburg not only showed that the wet grinding was hazardous and gave a false sense of security, but they also showed that the exhaust system in the dry-grinding plant was adequate.

Two important facts stand out as a result of this test: one is that wet grinding was not, here at least, a safe method; the other is that the methods of testing adopted in this test give an actual picture of the efficiency of the system of dust reduction installed.

Another corporation using the wet method of grinding, not satisfied with conditions in their grinding rooms, requested the Public Health Service to assist them in improving health conditions. The plant management realized that the mere compliance with the State laws in wet-grinding processes did not prevent a dust hazard. The labor turnover from accidents and sickness was very high, and the men employed in the grinding room were discontented because of the wet process in use and its attendant dust hazard.

A survey of the plant was made by Scientific Assistant Myron Bantrell,⁵ and dust samples from which counts were made were taken in various rooms of the plant. The counts were of one-fourth standard unit dust particles and ranged in number from 69,000 on the roof of building to 4,548,000 in the grinding room. The average number of particles in the grinding room was 2,841,000. These conditions prevailed notwithstanding the fact that the management complied with the State laws in every way in its wet-grinding process, using a special compound of oil and water.

This survey brings out the important fact that even a strict compliance with the present laws in regard to wet grinding does not always prevent a dust hazard, and that it is absolutely necessary to have some definite method of checking up the efficiency of dust-prevention devices after their installation.

These illustrations are not intended to depreciate wet grinding as a safeguard against air dustiness, but to point to the fact that wet grinding, as such, must not be allowed to allay suspicion and thereby cause plant managers or factory inspectors to fail to establish a satisfactory checking device against its possible failure. As a matter of

⁵ Bantrell, Myron, A Study of Occupational Health Hazards.

fact, numerous surveys have shown that dust particles in wet-grinding processes are often caused by the worker's regulating the flow of liquid to suit himself, decreasing the specified amount in order to protect himself from the spray and to increase the speed in his work. The stream of water is often out of line, the speed of the grinding wheel causes the spray to be thrown in all directions, and this spray carries metal and mineral particles to various parts of the room; the tool in process of grinding deflects the stream of water from the wheel, and thus the dust particles are not properly settled; in some plants the liquid solution is used continuously for a certain period of time, and therefore carries a certain amount of metal and metallic dust and bacteria in the solution; and in some instances workers were found to have discontinued the stream of water and hence were dry grinding without any method for settling the dust.

On the other hand, dry grinding with an exhaust system also has dangers and shortcomings; for care and attention must be given to the size and location of the hoods, the angle of taper of the ducts, the angle at which the branch pipes enter the main pipe, the use and size of the bends and elbows, the plugging and stoppage of the screens in the hoods, and, the most important factor, the suction maintained at the terminal hoods. I assume that it is generally known that there are several ways of testing the suction velocity of exhaust systems. One of the most popular is that of drilling a hole one-eighth inch in diameter in the suction pipe and applying to this hole the end of the rubber tube which is connected to a glass tube containing a colored solution and backed with a scale on which can be read the difference in the level of the two arms of the U-tube produced by the negative head in the suction pipe.

Using this method of testing the suction in the exhaust pipe, and the Palmer dust machine to count the dust particles in the air, Winslow, Greenburg, and Angermyer⁶ made a special study in the polishing shops of a small-arms plant by making observations in pairs: first, under normal conditions, with the exhaust system working, a dust count was made; then the doors in the main exhaust ducts were opened between the fans and the hood, and after an interval of 5 to 10 minutes, the work process being continued, a second dust count was made.

The results of these experiments showed that a reduction in the suction head readings of the U-tubes is quickly followed by an increase in the air dustiness; and a tabulation of the suction head pressure and the number of dust particles in these experiments proved that there is a definite relation between the suction head in the

⁶ Winslow, C.-E. A., Greenburg, L., and Angermyer, H. C., Standards for Measuring the Efficiency of Exhaust Systems in Polishing Shops: Public Health Reports, vol. 34, No. 10, March 7, 1919, pp. 427-449, Reprint No. 509.

exhaust and the dust in the air, provided there is no interference with the exhaust system between the point of the U-tube reading and the polishing wheels. And it is this possible defect in the arrangement of the hood with regard to slope, size, position, angle, and partial or total stoppage of the screen, that forces us to realize that the U-tube test is not always one of accuracy and reliability.

Not only do these experiments demonstrate this fact, but they demonstrate the fact that only by the actual dust count at the plane of work and of the atmosphere of the room could the efficiency of the exhaust system be checked or relied upon.

As to the two methods of preventing dust mentioned here, there are processes where dry grinding falls far short in giving a finished surface as compared with that obtained by wet grinding. There may be processes where dry grinding is preferable to wet; but both methods are essential, being determined by the character of the work and the finish desired.

Circumstances and the nature of the work to be done should determine the type of safety device to be installed. The air exhaust has certain advantages in sanitation, because the worker can not, by cutting off the fluid, convert the wet method into the dry method; there is no deflected spray in the dry method causing the clothes of the worker to become damp; hoods can be arranged in the dry method to catch any particles of dust liberated; the suction head at every grinding wheel can be tested in the dry method and a comparison of the amount of dust produced by each worker can be made, and in this way any defects in the separate hood and branch line can be located. There is no stream of water or liquid to be kept fixed on a certain point in the dry method. The dry method is cleaner, more comfortable for the workers, and less likely to produce discontentment among them.

The important point, however, in connection with the installation or maintenance of either the wet or the dry system, is that the supervision of its operation should guarantee efficient control of the dust caused by the process. This can best be accomplished by use of a dust sampling machine and a dust count.

No general standard of air dustiness has yet been worked out. An attempt is now being made by Prof. C.-E. A. Winslow and other workers in the Public Health Service. In the report made by Winslow, Greenburg, and Angermeyer⁶ the authors make the following statements from deductions drawn in extensive dust studies: "It appears then that the dust content of a polishing shop can be kept generally under 300,000 small one-fourth standard unit dust particles per cubic foot and should not average over 200,000."

But this tentative standard seems a probable one, as suggested by dust counts made from samples taken under ordinary conditions

⁶ Loc. cit.

to which men are exposed in offices, department stores, and on the street. Palmer, Coleman, and Ward ⁷ recorded the following dust content of the air of the city streets and occupied space where no particular dust hazard exists.

Source of samples.	Number of samples.	Average total count. ^a
Outdoors—Balcony City College.....	3	153,000
Outdoors—Woolworth Building (street level, 10th floor, and 58th floor).....	3	71,000
Business office.....	2	150,000
Department store, basement.....	4	108,000

^a The counts in this study included five sizes of particles, viz., 100-standard units, 25-standard units, 1-standard unit, and one-fourth standard unit.

This and the previous counts made under varying conditions demonstrate a method whereby standards for dustiness in any or all processes may be established. However, the standard mentioned here for polishing shops is tentative, and has been arrived at by engineers without the aid of medical officers. Physical examinations of the exposed workers, as well as X-ray plates of the lungs, in an intensive study over a long period of time, to see if the standard adopted for certain processes prevents the fibroid changes in the lungs produced by pneumoconiosis, must yet be made before the tentative standards can be accepted as adequate. It is in this direction that future work in dustiness must be conducted in hazardous industries to make the workplaces safe for the employees. This applies not only to grinding and polishing and to wet and dry exhaust systems, as here mentioned, but to all occupations and processes where dust hazards exist.

There are many factors which are essential to dust-prevention devices and systems; however, any one of them may be only slightly defective and yet cause the entire system to fail in its purpose. It is to the method of determining the efficiency and inefficiency of all devices for decreasing dustiness that I particularly wish to call your attention; because, as stated by Winslow, "the actual efficiency of any exhaust system or method for the control of the dust hazard can only be determined by the actual examination of the air in the work-room while the process is being carried on and the exhaust system at work."

I have reviewed briefly the findings of investigators of air conditions having a tendency to excite the development of tuberculosis, the question of the efficiency of certain devices and processes in eliminating the hazard, and the matter of tentative standards of air dustiness. Evidence shows that occupations which cause the worker to breathe dusts containing mineral and metallic dust particles rang-

⁷ Loc. cit.

ing from 1 to 10 microns in diameter, subject the individual to pneumoconiosis, caused by the rough, sharp, jagged, and hard dust particles, which predisposes to infection from the tubercle bacilli.

It has also been shown that the present methods used for removing dusts are subject to many faults and defects, and that it is only by an actual dust count at the plane of work and in the room or at the place where the process is being conducted that we can determine the efficiency of the system and the amount of protection that is afforded the worker; and that tentative standards of dustiness can be created, by making dust counts in any place and under any conditions desired, pending a study of living conditions to change the tentative to real standards.

I believe that I have made clear the following needs in the study of the control of air dustiness:

1. The necessity for establishing a "standard dust table" of the number of dust particles of a certain size permissible in all dust-creating or dust-hazardous processes and occupations.

2. The necessity for checking the efficiency of all dust-removing systems or devices at regular intervals by an actual dust count at the plane of work and in the workroom, which count must come within the limits prescribed by the "standard dust table" for that particular process.

If these two suggestions should be adopted and included in every State law for the control of air conditions in industries, the amount of pneumoconiosis would be unquestionably reduced, and the mortality from tuberculosis in dusty trades diminished.

If, in addition to the establishment of the "standard dust table" and the regular testing of dust-removing devices in plants by actual dust count, intensive education of employees as to their constant danger of tuberculous infection at home and in the plant is carried out and workers come to realize the hazards to which they are subjected, we may expect to lower the present industrial mortality rate from tuberculosis to that of the ordinary death rate.

AMBULATORY TREATMENT OF DRUG ADDICTION.

THE PENNSYLVANIA STATE DEPARTMENT OF HEALTH CONSIDERS IT A VIOLATION OF THE STATE ANTINARCOTIC LAW.

In an article published in Public Health Reports for July 18, 1919,¹ the ambulatory treatment of drug addiction was defined and held to be presumptively a violation of the Harrison narcotic drug act. As the Pennsylvania antinarcotic law follows the Harrison law very closely, the action of the commissioner of health of Pennsylvania in the order published herewith, declaring the ambulatory treatment of

¹ Treatment of Drug Addiction, by Arthur D. Greenfield, Attorney and Counselor at Law.